

**New Program Proposal  
Master of Science and Doctor of Philosophy in Automotive Engineering  
Clemson University**

**Summary**

Clemson University requests approval to offer programs leading to the Master of Science and Doctor of Philosophy degrees in Automotive Engineering, to be implemented in Fall 2006.

The proposal was approved by the Clemson University Board of Trustees on October 25, 2002, and submitted for Commission review on May 4, 2005. The proposal was reviewed without substantive comment and voted upon favorably by the Advisory Committee on Academic Programs at its meeting on July 14, 2005. The proposal combines and presents simultaneously the fiscal projections, faculty projections, facility and library needs and resources, and curricular offerings for both the M.S. and Ph.D. degrees; enrollment projections are presented separately for each program.

The purpose of the programs is to prepare a new generation of engineers to deal with the complex technological, environmental, and globalization issues facing the automobile industry. The emergence of the programs is a direct response to three fundamental changes affecting the automobile industry: shifts in the relationships between automobile equipment manufacturers and their suppliers; globalization of the automotive marketplace; and the impact of advances in technology upon automobile design, manufacture, and systems integration. The programs also reflect the evolution of Clemson's International Center for Automotive Research (ICAR) which, in addition to its partnerships with BMW and Michelin in the upstate region, has been awarded \$18 million in state lottery funds for four Research Centers of Economic Excellence (Endowed Chairs Program) over the last three years.

Graduates of the programs will have highly specialized skills in Systems Integration and Vehicle Systems Engineering and will be equipped to lead teams of culturally diverse individuals in producing integrated automobile platforms or working in research laboratories. Because some of the underlying engineering concepts are common to other fields of research, graduates may also be equipped to pursue careers in aerospace and other engineering-related industries that are facing the challenges of globalization and the integration of technological advances. Dating back to the late 1980's, Clemson's Department of Mechanical

Engineering has enjoyed considerable success in placing program graduates in the automotive and motorsports industries. Many potential employers for graduates of the proposed program have already expressed their enthusiasm and encouragement for Clemson's efforts to develop these courses of study.

A particularly unique aspect of the proposed program is that, in addition to an emphasis on technical skills related to engineering, there is an emphasis on interdisciplinary technical depth and cross-cultural communication in a business environment. Nationally, there are no comparable Ph.D. programs and only a handful of Masters programs. Both the University of Michigan and Kettering University offer an M.S. in Automotive Engineering; the University of Michigan also offers a Master of Engineering degree. There are no automotive engineering programs in the southeastern United States.

In April, 2005, the proposed program was reviewed by the Director of the Applied Research Laboratory at Pennsylvania State University. The external review reached three noteworthy conclusions: the proposed program is unique within the United States; the Department of Mechanical Engineering at Clemson is "very capable" of implementing the program; and the proposed admissions criteria are "very good." There were no substantive shortcomings noted in the external review. Overall, the external reviewer offered a "strong recommendation" of the program while suggesting that it would "raise [Clemson's] stature amongst its peer institutions world-wide."

All undergraduate engineering programs in the College of Engineering and Science are accredited by the Accreditation Board for Engineering and Technology (ABET). Graduate programs are required only to be accredited by the Southern Association of Colleges and Schools (SACS). The proposed programs will be reviewed under SACS guidelines.

The proposal notes that recruitment and enrollment will be selective, projecting 20 students in year 2005-06 (15 M.S., 5 Ph.D.), and adding an additional 20 students the second year, bringing the total to 40 (30 M.S., 10 Ph.D.). Enrollment projections for years 3-5 suggest a maximum of 30 M.S. students and 20 Ph.D. students when the program is at capacity. If enrollment projections are met, the program will meet the Commission's productivity standards.

Admission to the M.S. program requires a B.S. degree from a recognized relevant engineering or science discipline and the equivalent of two years of post-B.S. full-time work experience. The proposal notes that, at the suggestion of BMW, Michelin, and other partner companies, the work experience requirement is

highly desirable. Admission to the Ph.D. program requires meeting the M.S. admission criteria and a G.P.A. of 3.5 or higher.

The proposed M.S. program will consist of 42 semester hours, including: 12 semester hours in automotive systems integration; 18 semester hours in automotive engineering; 6 semester hours in business or related fields; and six semester hours for a six-month industrial internship. The proposed Ph.D. program will consist of 66 semester hours, including: 9 semester hours in systems integration; six semester hours in automotive engineering; 15 semester hours in technical courses within the discipline; nine semester hours in technical courses outside the discipline; three semester hours in business or a related field; 18 semester hours for the dissertation; and, six semester hours for a six-month residency at a foreign research lab or university. The proposed program includes 31 highly technical and field-relevant new course offerings that range from “AuE825: Automotive Sensors and Actuators” to “AuE829: Tire Behavior and Its Influence on Vehicle Performance.”

The M.S. and Ph.D. programs will be delivered by four new senior faculty (3.75 FTE) who will be hired to fill Endowed Chairs associated with the Research Centers of Economic Excellence. These senior faculty will be supported by six new junior faculty (6.0 FTE) hired at the Assistant and Associate level. The Endowed Chair in Systems Integration will serve as the director of the proposed program (0.25 FTE). The proposal also notes the addition of ten new staff (five technicians, four administrative assistants, and a staff engineer, totaling 10.0 FTE).

The proposal states that the programs will be housed in an 85,000 square foot facility currently being built in Greenville, South Carolina. The facility will include several pieces of specialized equipment used to perform engineering tests on full-scale automotive vehicles.

The proposal also anticipates a need to expand library holdings, due to shortcomings relative to peer institutions. Needed are new journal titles, books and conference proceedings, the complete IEEE on-line package, and INSPEC databases. The budget reflects varying annual estimates of the costs of acquiring these library resources, ranging from \$120,000 in year one to \$50,000 in the fifth year, and totaling \$390,000 over a five-year period.

New costs for the program are estimated to begin at \$4,634,569 in the first year, decreasing to \$4,201,577 in the second year, decreasing to \$4,052,918 in the third year, increasing to \$4,267,717 in the fourth year, and increasing to \$4,396,073 in the fifth year. Categories of costs over the first five years of the program’s implementation include faculty salaries (\$6,222,838); program administration (\$1,408,116); graduate assistants (\$1,400,000); clerical and support

personnel (\$2,307,104); supplies and materials (\$213,365); library resources (\$390,000); equipment (\$1,912,560); facilities (\$5,343,666); and other operations and management (\$2,344,205). Total estimated new costs for the program during the first five years will be \$21,552,854.

Shown below are the estimated Mission Resource Requirement (MRR) costs to the state and new costs not funded by the MRR associated with implementation of the proposed M.S. and Ph.D. programs, respectively, for their first five years. Also shown are the estimated revenues projected under the MRR and the Resource Allocation Plan as well as student tuition.

M.S. in Automotive Engineering

Year	Estimated MRR Cost for Proposed Program	Extraordinary (Non-MRR) Costs for Proposed Program	Total Costs	State Appropriation	Tuition	Total Revenue
Year 1	\$548,044	\$0	\$548,044	\$0	\$166,628	\$166,628
Year 2	\$1,096,088	\$0	\$1,096,088	220,810	\$334,710	\$555,520
Year 3	\$1,096,088	\$0	\$1,096,088	442,214	\$334,710	\$776,924
Year 4	\$1,096,088	\$0	\$1,096,088	442,214	\$334,710	\$776,924
Year 5	\$1,096,088	\$0	\$1,096,088	442,214	\$334,710	\$776,924

Ph.D. in Automotive Engineering

Year	Estimated MRR Cost for Proposed Program	Extraordinary (Non-MRR) Costs for Proposed Program	Total Costs	State Appropriation	Tuition	Total Revenue
Year 1	\$569,742	\$0	\$569,742	\$0	\$94,210	\$94,210
Year 2	\$1,139,483	\$0	\$1,139,483	229,399	\$190,265	\$419,663
Year 3	\$1,709,225	\$0	\$1,709,225	460,185	\$284,475	\$744,660
Year 4	\$2,278,967	\$0	\$2,278,967	689,583	\$378,686	\$1,068,269
Year 5	\$2,278,967	\$0	\$2,278,967	918,982	\$378,686	\$1,297,668

These data demonstrate that if the institution meets the projected student enrollments and contains costs as they are shown in the proposal, neither the M.S. nor the Ph.D. program will be able to cover costs during each of its first five years. The tables above, however, do not reflect the several extraordinary costs and

revenues for these programs. For example, over the last three years Clemson has been awarded \$18 million in state lottery funds for four Research Centers of Economic Excellence “Endowed Chairs” that are associated with ICAR. Faculty filling the Endowed Chairs will serve as four the ten proposed new faculty, with six new junior faculty supporting and collaborating in the work of the Endowed Chairs. When leveraged with \$18 million of required matching funds from Clemson, the total of \$36 million adds considerable fiscal stability to the proposed program. In addition, recent Research Center Review Board approval of a \$47.6 million building project, associated with the Research University Infrastructure Act, addresses many of the facility and equipment needs associated with the proposed program. Thus, while the MRR allocation falls short, there is clearly considerable momentum to generate funding through other mechanisms, including private donations, the Endowed Chairs program, and the Research University Infrastructure Act (which is part of the Life Sciences Act).

In summary, Clemson University will offer programs leading to the Master of Science degree and the Doctor of Philosophy degree in Automotive Engineering. The program takes an interdisciplinary approach to training engineers; program graduates will have highly specialized skills in Systems Integration and Vehicle Systems Engineering and will be equipped to lead teams of culturally diverse individuals in producing integrated automobile platforms or working in research laboratories.

### **Recommendation**

The staff recommends that the Committee on Academic Affairs and Licensing commend favorably to the Commission Clemson University’s Master of Science and Doctor of Philosophy in Automotive Engineering programs to be implemented in Fall 2006, provided that no “unique cost” or other special state funding be required or requested.